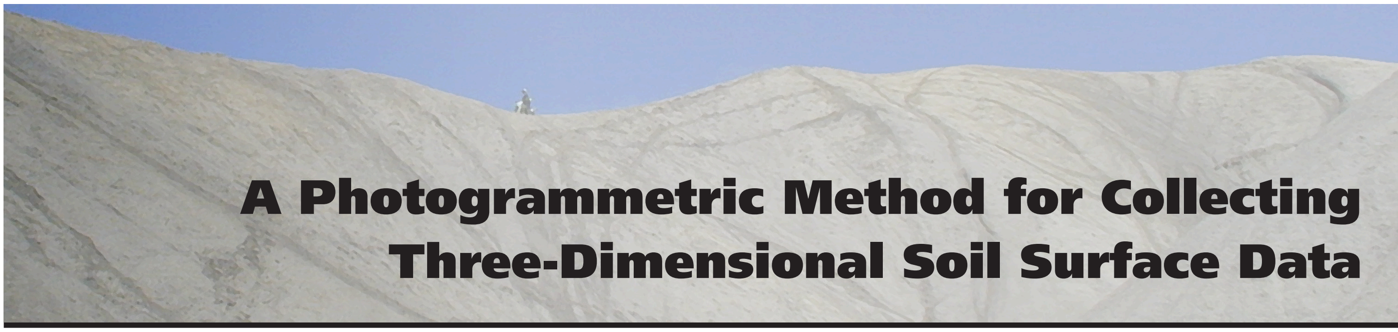

A Photogrammetric Method for Collecting Three-Dimensional Soil Surface Data

BLM

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Soil Surface Features

Soil surface features are important characteristics that affect the functions of soils in the landscape. Surface features are distinguished by differences in texture, orientation of particles, rock fragments, films, organic matter content, color, packing, pores, chemistry, microrelief, and soil crusts (biological, physical, and chemical), as well as other characteristics. Some of these features, such as biological soil crust presence and morphology, and changes in soil elevation due to erosion or disturbance, can be recorded and quantified by using extreme close-range (less than 50 m from camera to object) photogrammetry. Surface features can greatly influence or be associated with soil functions such as infiltration, runoff, erosion, nutrient status, seedling establishment, and other vital functions.

Extreme Close-Range Photogrammetry

The photogrammetric method developed by the Bureau of Land Management's National Science and Technology Photogrammetry Staff has the potential to be a valuable tool for measuring soil surface elevation and changes in that elevation caused by wind and water erosion, physical displacement, raveling, and localized soil creep. Other potential uses include the recording of biological soil crusts presence, functional groups, and changes in microtopography. Softcopy workstations create a digital terrain model that consists of a closely spaced grid of thousands of x, y, z data points. Digital terrain model grid spacings of 1 to 2 mm and positional accuracies of 0.25 mm can be determined for areas as large as 5 m^2.

Soil Erosion Monitoring

Soil erosion is difficult to measure in an accurate, cost-efficient way. Several methods available include trapping sediment behind silt fences, collecting runoff and sediment from bordered plots, and using an erosion bridge. The use of sediment fences and the collection of runoff and sediment from bordered plots are time-consuming, can result in considerable loss of sediment, and do not take into account wind erosion. In addition, these methods are not appropriate where activities such as off-highway vehicle (OHV) use need to be monitored, since the use would destroy the silt fences or plots. The erosion bridge measures erosion on an extremely small sample; plus, the protruding erosion bridge support pins would be a hazard to OHV users and would be disturbed and rendered inoperable by this type of use.

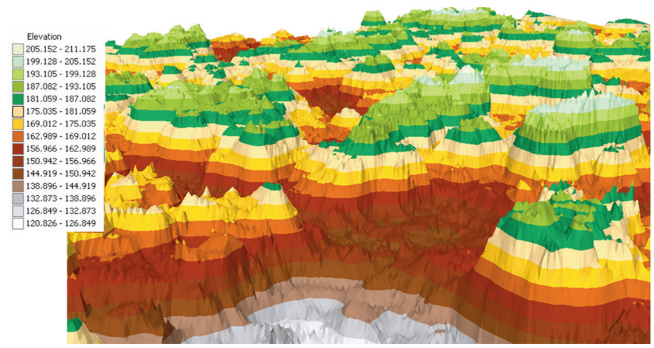
Off-Highway Vehicle Monitoring

Off-highway vehicle use is increasing on public lands as the population of the western States where this land occurs continues to grow. A variety of motorized vehicles are involved, including factory-built four-wheel drive vehicles, all-terrain vehicles, dirt bikes, and extreme off-highway vehicles. Off-highway vehicle use is monitored by the Bureau of Land Management (BLM) to ensure that effects are within acceptable limits imposed by the laws and regulations governing public land management.

Off-highway vehicle use can accelerate wind and water erosion and soil raveling by reducing cover and soil surface stability. Physical soil displacement can also occur because of wheel spinning and sliding.

One of the latest crazes in recreational activity on public lands is extreme OHV use. Modified four-wheel drive vehicles are used to climb the most difficult terrain possible. Areas that have previously been inaccessible by large motor vehicles, often in intermittent streambeds, are now being accessed by increasing numbers of participants. This has created a need for accurately determining erosion rates and soil displacement to monitor the effects of this activity on the environment. The BLM Montrose (Colorado) Field Office is using the extreme close-range photogrammetry method to monitor extreme OHV use in Dry Creek Basin and dirt bike use in an open area in the Mancos Shale hills. Unaffected areas will be used as a control for the monitoring.

Biological Soil Crust Monitoring



Biological soil crusts are a vital component of rangeland ecosystems in the western United States, and especially in the Colorado Plateau ecoregion. They impede erosion, add nutrients to the soil, improve water availability to plants, and impede the spread of cheatgrass (*Bromus tectorum*). The pinnacled microtopography of the biological soil crusts in the Colorado Plateau is an indicator of their successional state and ability to detain surface runoff and improve infiltration. Biological soil crusts can be damaged by disturbance, especially when dry. Limited recovery can occur in a relatively few years but late successional stages can take more than 500 years for recovery in the Colorado Plateau. Extreme close-range photogrammetry can accurately document the changes in microtopography of biological soil crusts to submillimeter accuracy. A preliminary test was performed by using a standard lens and color infrared lens on biological soil crusts in Dry Creek Basin near Montrose, Colorado. The preliminary results of the test indicated that the extreme close-range photogrammetry methodology is a valid technique for monitoring biological soil crusts.

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